strong flame lines λλ 4227, 4607, and 5535 of calcium, strontium, and barium, respectively. In each case a temperature was found at which no emission could be detected, but when white light was sent through the furnace the lines appeared distinctly in absorption. For these favorable lines, the view of Saha is thus confirmed. It will be of interest to test other series lines in the same way.

In previous investigations on the absorption of vapors of the alkali metals, the lines of the principal series have appeared, but not those of the subordinate series. Since in emission spectra the latter require higher temperatures than the principal series lines, it seemed probable that a relatively high temperature was required to produce them in absorption. Experiment showed this to be the case. Sodium, potassium, caesium, and rubidium were tested by heating to a high temperature in a tube having a plug to give the continuous ground. The subordinate series lines appeared in absorption for each element.

The general character of the absorption phenomena in the furnace may be described as in general a reversal, when white light is passed through the tube, of the emission spectrum at the same temperature. Exceptions are found in the easily excited principal series lines and perhaps others, which the vapor can absorb before it emits, and in the ultra-violet region beyond the limit, at the given temperature, of the black-body radiation. In the latter case an absorption spectrum appears beyond the emission limit when a sufficiently hot source of white light is employed.

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## *PRELIMINARY NOTE ON A BIOMETRICAL STUDY OF THE RELATIONS OF CERTAIN VISCERA IN TUBERCULOSIS*[1]

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One of the most fundamental problems of biology is that of adaptive regulation to the end of maintaining the life of the individual. The ability to readjust the functional relations of the parts of the organism, after they have been in any way disturbed is widespread among living things generally, including man. A well-known example is seen in the functional hypertrophy of the kidney. If one kidney is removed the remaining one promptly enlarges and carries on the work formerly divided between the two. Many similar examples might be cited.

We have been engaged for the past year in a study of this phenomenon of adaptive functional regulation from a somewhat new point of view. Starting from the justifiable assumption that the records of pathological anatomy, as set down in autopsy protocols, should if adequately analyzed

give a picture of regulatory processes perhaps more detailed and definite than is likely to be found elsewhere, it seemed probable that quantitative study of the ratios existing between the weights of the more important viscera would indicate with great exactness any disturbances in the normal balance of the parts of the organism. The results, we believe, fully bear out this assumption. This first investigation, which has just been completed, was restricted entirely to tuberculosis as the pathological condition involved. This choice was deliberate and based upon the known profound constitutional effects of the disease. The data studied are six organ-weight indices or ratios, defined as follows:

$$\text{Index A} = \frac{\text{Liver weight}}{\text{Heart weight}} = \text{L/H}$$

$$\text{Index B} = \frac{\text{Liver weight}}{\text{Spleen weight}} = \text{L/S}$$

$$\text{Index C} = \frac{\text{Liver weight}}{\text{Right kidney weight} + \text{Left kidney weight}} = \text{L/K}$$

$$\text{Index D} = \frac{\text{Heart weight}}{\text{Spleen weight}} = \text{H/S}$$

$$\text{Index E} = \frac{\text{Right kidney weight} + \text{Left kidney weight}}{\text{Heart weight}} = \text{K/H}$$

$$\text{Index F} = \frac{\text{Right kidney weight} + \text{Left kidney weight}}{\text{Spleen weight}} = \text{K/S}$$

These indices were calculated from the data given on the protocols of such of the first 5000 autopsies (1341 in all) of the Johns Hopkins Hospital as revealed tuberculous lesions, and at the same time conformed to certain other requirements. The material was divided for purposes of study by race, sex, activity or quiescence of lesion at time of death, age, and character of lesion.

The age characteristics of this autopsied, tuberculous, hospital population were compared in detail with those of the general population, and with that part of it dying of tuberculosis. In general there is a close agreement in mean age at death between the autopsied hospital population showing active tuberculous lesions, and the portion of the general population dying of tuberculosis.

One of the most interesting and novel results of the study has been to show that certain of these organ-weight indices change with the age of the individual. These changes may be looked upon as phenomena of senescence beginning very early in life, indeed practically at birth. The detailed results as to correlation with age may be briefly summarized as follows. There is a significant *negative* correlation in all groups between the value of Index A and age. This means that as age advances the liver/heart ratio tends to take on lower and lower values. Index B is, on the whole

not significantly correlated with age. The same is also true of Index C. With the exception of the white groups with active tuberculous lesions, which show no sensible correlations of this index with age, there is generally a significant *positive* correlation of Index D with age. Index E exhibits a relatively high, and in general certainly significant *negative* correlation with age. Index F is not correlated with age. Inasmuch as the material included all ages from infancy to extreme old age, these correlational results with age have a general biological significance. They indicate that, so far as the present material may be trusted to portray general relationships, the functional balance of certain organs, notably the heart and spleen, changes throughout life in an orderly manner, capable of expression by mathematical equations. Such regression equations, which are throughout linear in character, were computed for all cases where the correlation coefficients were significant, and made the basis of later corrections of the biometric constants of the indices, to allow for the influence of age.

A detailed study of the relation of race (white or colored) to the values of the several organ weight indices, after proper corrections had been made for the influence of age, leads to the general result that where there are no lesions in either of the organs involved in an index and where the number of cases is large enough to give reliable results, there is, broadly speaking, no difference between white and colored racial groups in either mean or variability, except in the case of Indices B and D. In these cases it is only the means and not the relative variabilities that differ. In both cases it is the colored group that has the higher value for the indices.

In general there are no significant differences between the sexes in either mean values or variability of the indices, after proper corrections have been made for the influence of age. In these organ-weight indices we are evidently dealing with fundamental functional characteristics of the organism, which express in a hitherto unnoted way the extraordinary regulatory powers which are in a profound manner associated with the maintenance of life. The absolute weights of the several viscera may differ widely in the different races and sexes, but the ratios of these same viscera, in respect of weight, appear from the present experience to have a constancy and stability biometrically, which, broadly speaking, entirely transcends the influence of race and sex.

After making proper corrections for differences in the age distributions of the groups involved, the question of the influence of tuberculosis *per se* upon the organ-weight indices was attacked. This problem was approached in several ways of which the most significant was to compare two groups of which one contained only cases wherein the *sole* significant lesions at death were those of tuberculosis, while the other contained cases where in addition to the tuberculous lesions present (active or inactive) were

*other* lesions in themselves sufficiently grave to have caused death, had there been no associated tuberculosis. On the basis of this grouping it is found that five of the six indices (namely all those involving heart or spleen or both) show large and significant differences as between the two groups. These differences everywhere are of the sort which would arise if the effect of fatal tuberculosis was to lower the absolute weight of the heart and increase that of the spleen. The significance of these results, as well as that of the differences in mean age at death in the two groups will be discussed in the detailed paper, which will appear in the Reports of the Johns Hopkins Hospital.

The work is being continued with other pathological groups, and it is believed will become more interesting and significant as we become able to compare the results from different types of lesions.

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## *THE EFFECT OF ETHER UPON THE MIGRATION OF THE SCALE PIGMENT AND THE RETINAL PIGMENT IN THE FISH, FUNDULUS HETEROCLITUS*

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When an adult Fundulus is etherized the pigment in the scale melanophores shows a complete distal migration and the fish becomes dark in color. In this respect ether produces an effect the reverse of adrenalin. But adrenalin not only causes a proximal migration of the scale pigment; it induces a distal migration of the retinal pigment (Gilson, '22). Does ether also influence the retinal pigment and, if so, is its effect on that pigment the reverse of that of adrenalin? To test this question Fundulus was etherized either in the dark or in the light and its eyes prepared for study. Fish that had been some time in the light were etherized by allowing a stream of 5% ether to drip upon the gills from ten to fifteen minutes. Before etherization the scale melanophores showed a complete proximal migration of the pigment granules. Within one to four minutes after the application of ether had begun the melanophores were in a state of complete distal migration. At the end of ten or fifteen minutes the animals were killed and the eyes were prepared. The same procedure was carried out upon fish that had been kept in the dark. 5% ether was also applied to both light and dark fish by immersing the body as far as the gills in the ether solution for twenty or thirty minutes after which their eyes were prepared. The scale melanophores of light fish which were immersed